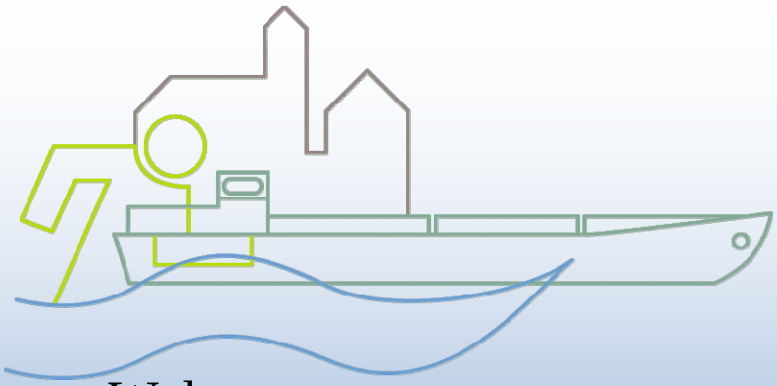

# Welcome

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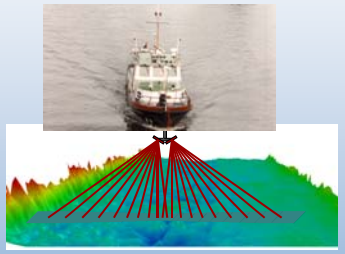
hydro 2010

Rostock-Warnemünde, 02.-05.11.2010



## Surveying of extremely shallow waters with optimized multibeam echosounders and surveying vessels

**-Development of a combined MBES-**

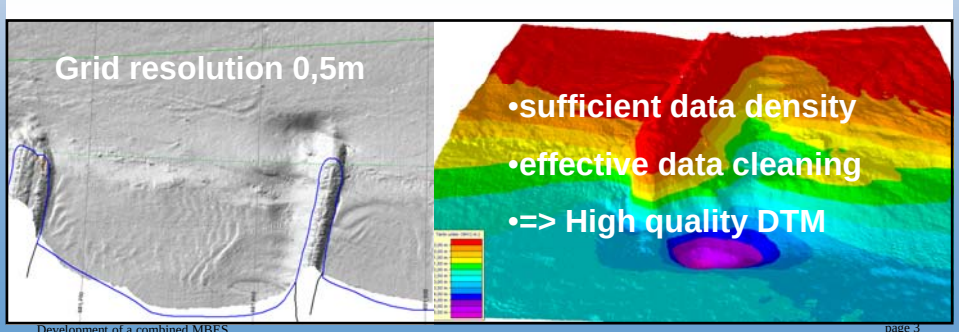


1. Basics
   - Requirements
   - Implementation Concept
2. Field test results
   - Surveying vessel type
   - MBES investigation and development
   - Combined System Efficiency
3. Summary

# Requirements

**Basis requirements**

- draught less than 1.2m,
- suitable in waters deeper than 2.0m,
- number of outliers within acceptable scale,
- 5-10 measurements/m² (for 1m spaced grids)

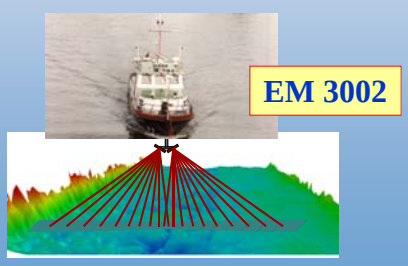





# Implementation Concept

**Increase of efficiency by**

| | |
|---|---|
| criterion 1: | maximizing the area covered by one sounding, |
| criterion 2: | maximizing speed over ground during data acquisition, |
| criterion 3: | minimizing overlap of swathes. |




**Requirement:**

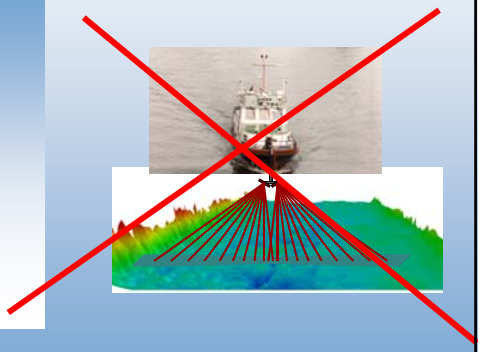
MBES with equal-distance beamforming, => homogenous distributed measurements in each ping

# Implementation Concept

**Criterion 1: maximizing the area covered by one sounding**

**Results of former tests (2007) with EM 3002:**

- **excessive number of outliers,**
- **no use of measurements with grazing beam angles > 70°**
- **Explanation of cause by Kongsberg: reflexions at water surface, reduce mounting angle**

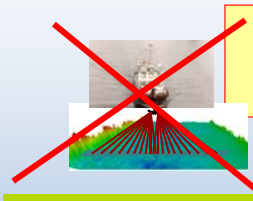


**Optimization of MBES respectively transducer alignment is absolutely necessary**

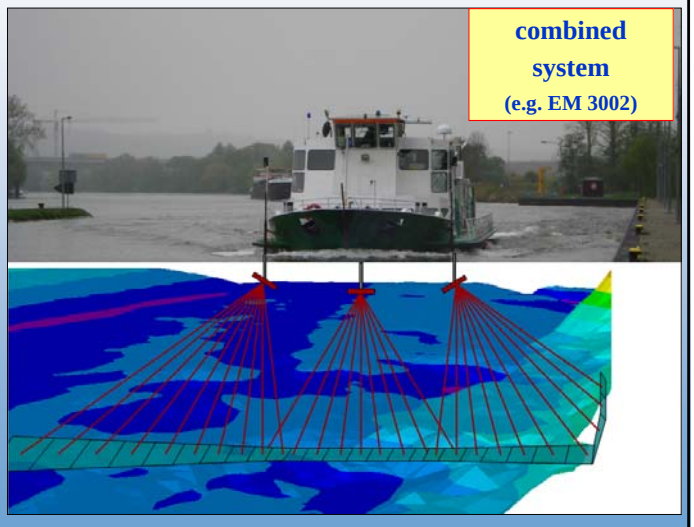


# Implementation Concept

**Criterion 1: maximizing the area covered by one sounding**



**equal angle system (e.g. EM 3000)**



**combined system (e.g. EM 3002)**

**Optimization of transducer alignment**

**by :**

- **combining two MBES**
- **varying outer transducer mounting angle between 25° and 40°**

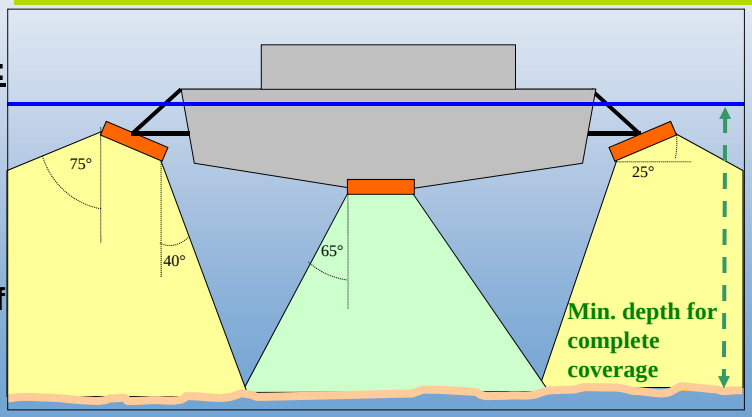
# Implementation Concept

**Criterion 1: maximizing the area covered by one sounding**

**maximizing the swath width by combining 2 MBES**

**Complete coverage if:**

- **distance between outer transducers > 8m and depth > 1.8m**
- **transducers are mounted at a depth of 0,5m**






# Implementation Concept

**Criterion 2: maximizing speed over ground during surveying**

**Standard surveying boat speed limit against current = 8Km/h**

**What should be the maximum speed of the optimised system?**

**Limits by vessel:**

- the legally allowed speed in canals is usually 12 km/h
- the future surveying vessel should be capable to hold a speed of 12 Km/h against the current.

**Limits by MBES:**

- Data density perpendicular to the sailing direction ~at least one point every 20cm

⇒ a ping rate of 8Hz must be guaranteed at any circumstance

# Survey vessel type

## Criterion 3: minimizing overlap of swathes

Overlap of swathes is essential because gaps must be avoided.

**5m overlap: roll angles should be < 3°, navigation precision of 2-3m**

Surveying vessel suitability test:

16m monohull standard surveying boat versus 25m catamaran



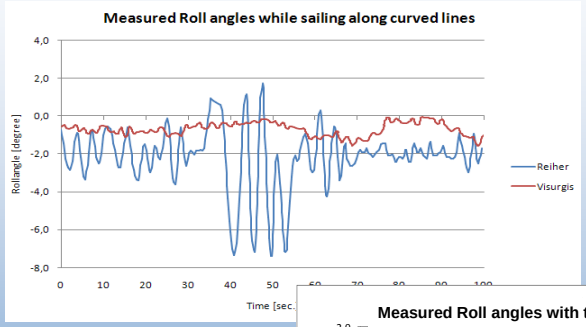
# Survey vessel type

## Criterion 3: minimizing overlap of swathes

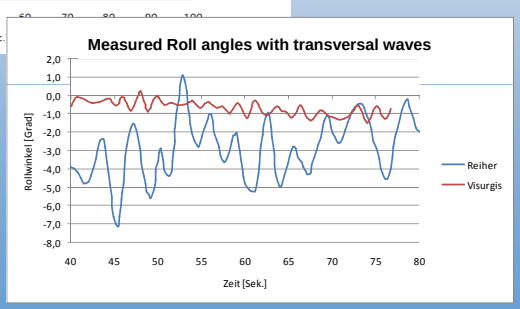
catamaran

versus

monohull surveying boat



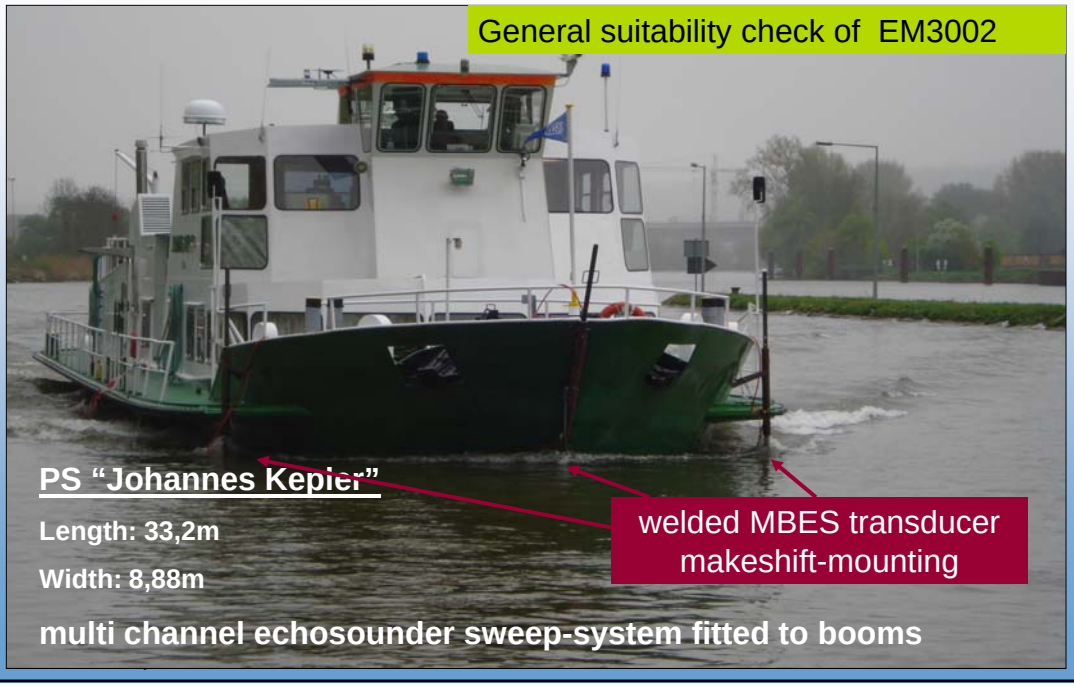

Investigation of the dynamic behaviour pattern of the vessels




- The monohull boat rolls up to 8°
- The catamaran meets the requirements:
  - roll angles <<3°,
  - Easy and precise navigation along survey routes.

# MBES investigation and development

General suitability check of EM3002

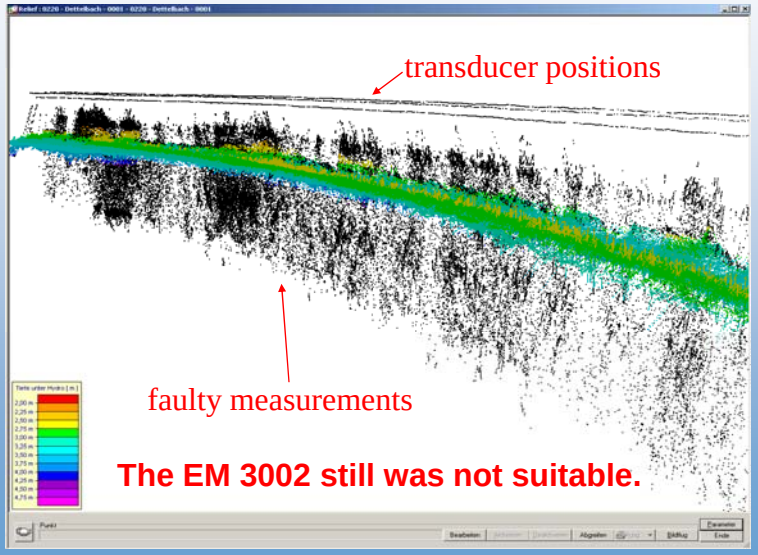



# MBES investigation and development

General suitability check of EM3002

**Results:**

- **still excessive number of outliers,**
- **no correlation between the errors and the mounting angle,**
- **errors occured even with only one MBES.**

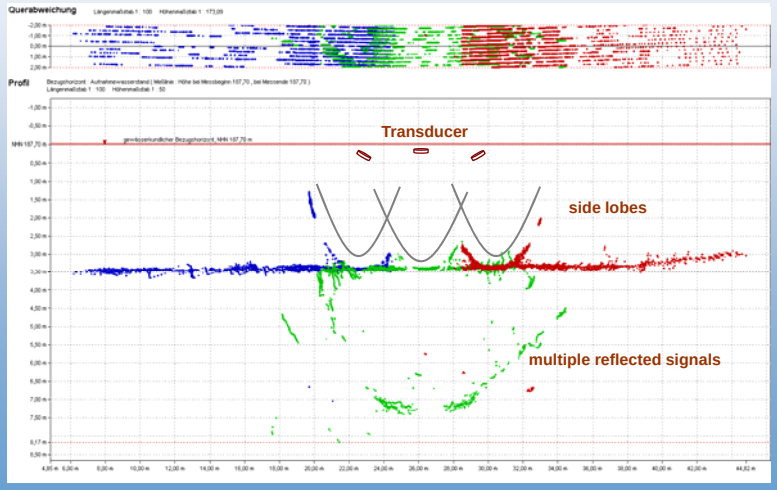


# MBES investigation and development

## General suitability check of EM3002

**Error sources:**

- **due to multiple path (firm subsoil),**
- **due to signal interference between main and side lobes,**
- **due to strongly reflecting small objects (rip-rap-stones),**
- **filtering causes insufficient data density**



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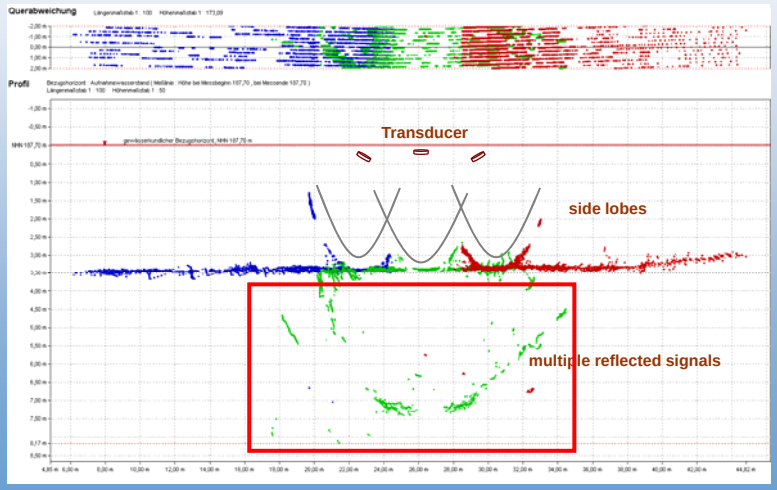

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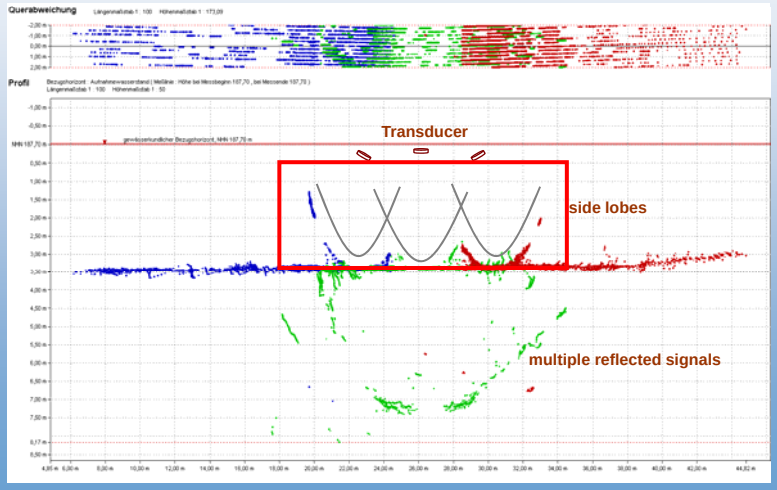




# MBES investigation and development

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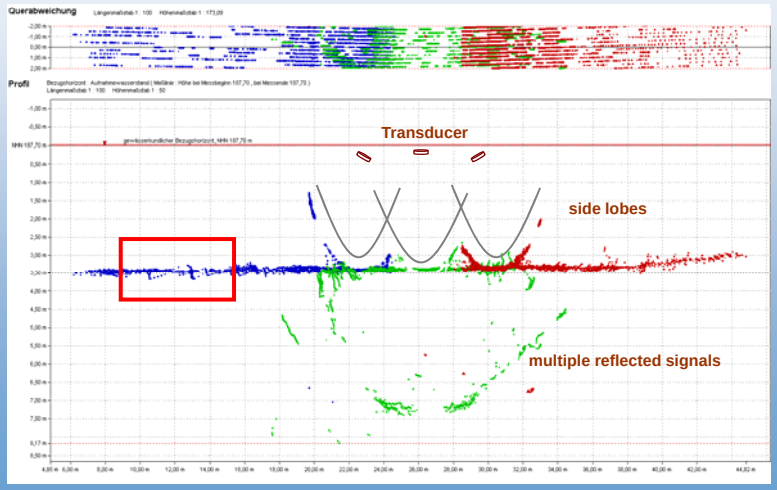

# MBES investigation and development

## General suitability check of EM3002

**Error sources:**

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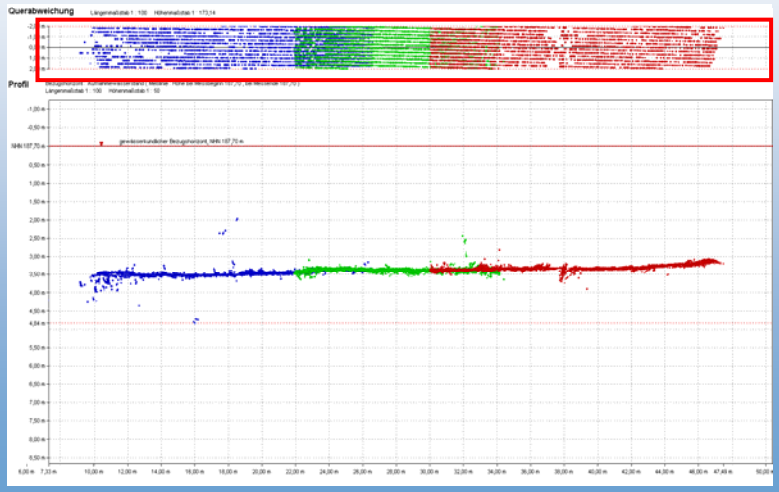
# MBES investigation and development

## General suitability check of EM3002

**Results after improvement of bottom detector by Kongsberg:**

- **satisfactory reliability and accuracy,**
- **sufficient data density.**

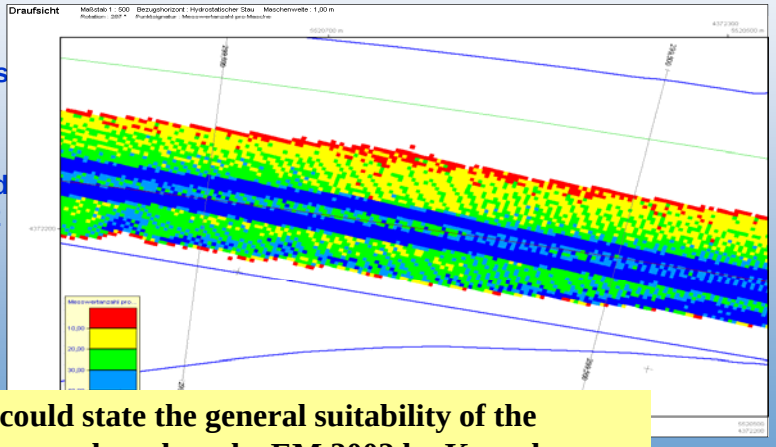


# Combined System Efficiency

data density and SOG

**Will the required data density be accomplished?**

- **triggering reduces frequency of soundings to 9 Hz (depth < 4,5m),**
- **data density is sufficient, even if speed over ground rises to 12 km/h,**



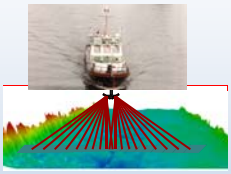

**Finally we could state the general suitability of the combined system based on the EM 3002 by Kongsberg.**



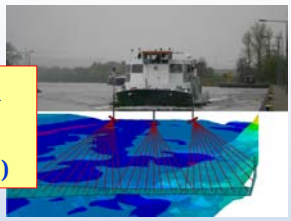
# Combined System Efficiency

systems comparison

**equal angle system (e.g. EM 3000)**



**combined system (e.g. EM 3002)**



**distance between outer transducers ca. 8m, mounting at 0,5m depth**

## Disadvantages:

- **Time and effort for calibration + 30%**
- **surveying system is + 35% more expensive**
- **high procurement costs for the vessel + 150%**

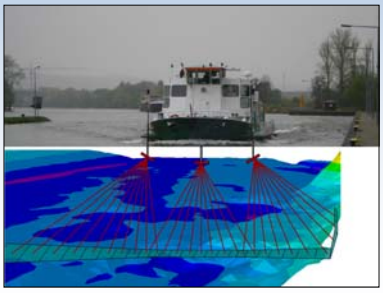
| River, average fairway-width of 150 m | | | |
|---|---|---|---|
| Depth [m] | No. of lines equal angle system, 50% overlap | No. of lines combined system, 5m overlap | **Increase of efficiency (including 33% higher SOG)** |
| 2,0 | 23 | 11 | **142%** |
| 3,0 | 14 | 7 | **133%** |
| 4,0 | 10 | 5 | **133%** |

# Summary

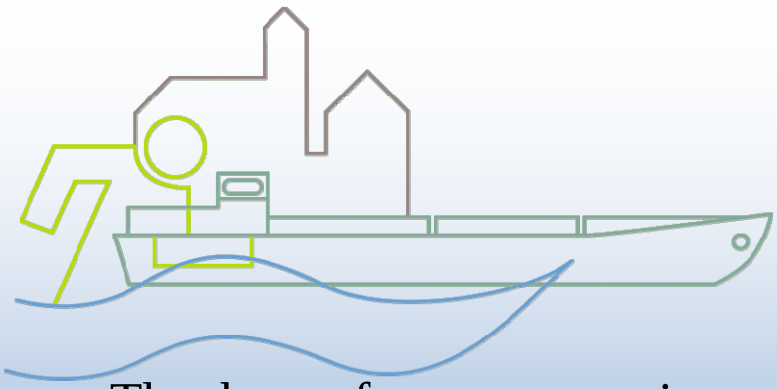
- **The Kongsberg MBES EM 3002 was enhanced for applications on inland waterways.**
- **The suggested transducer alignment is practicable.**
- **The tests showed the general applicability of a combined MBES on inland waterways**

**A combined MBES:**

- **increases efficiency over 130%**
- **is a must in extremely shallow waters (depth > 2m)**







# Thank you for your attention

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